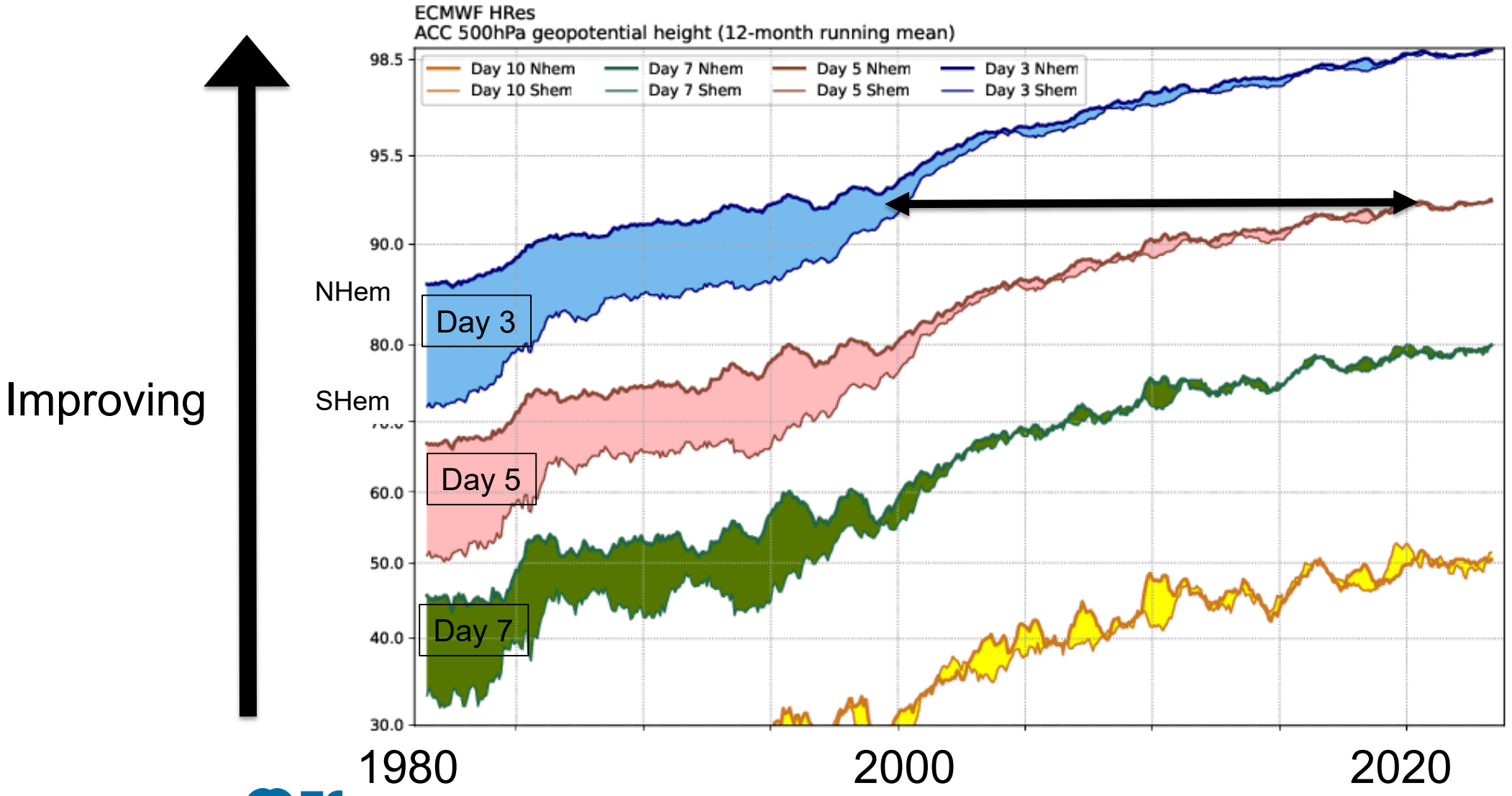
ECMWF strategy and research directions

Andy Brown

Director of Research

ECMWF

Dramatically improving accuracy…….



What has made things better?

More and better observations

- Number, accuracy, variety

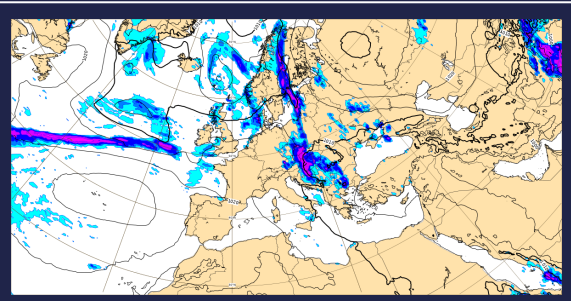
Bigger supercomputers

- More expensive choices possible (e.g. model resolution)

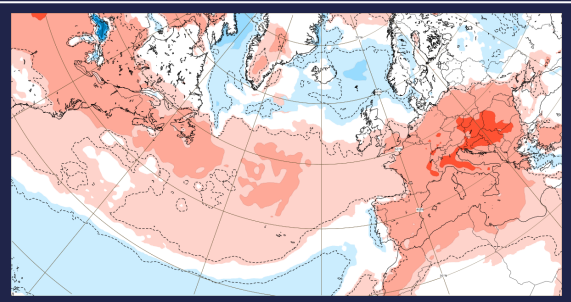
Better science

- Clever people!
- Partnerships

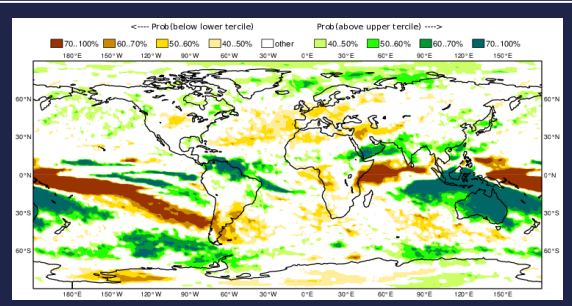
Medium range: up to 2 weeks



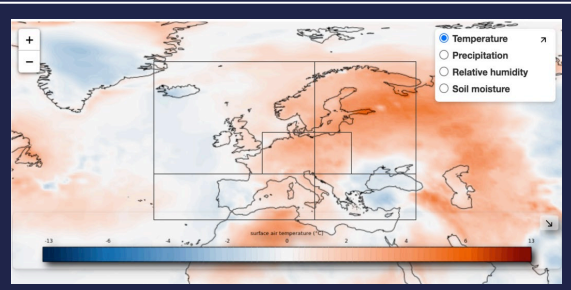
Sub-seasonal range: up to 6 weeks



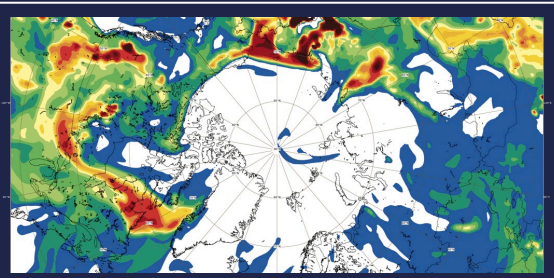
Seasonal range: up to a year



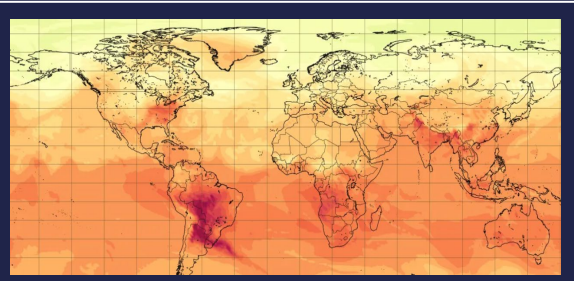
Climate monitoring



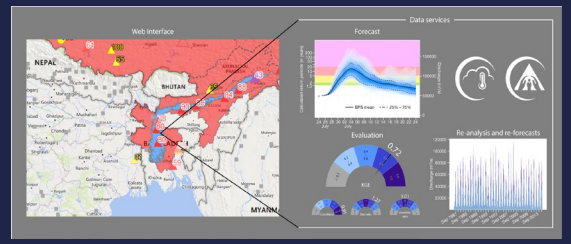
Air quality forecasts



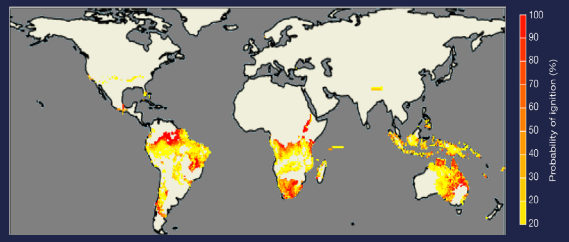
Greenhouse gas forecasts



Hydrological forecasts



Wildfires: probability of ignition by lightning

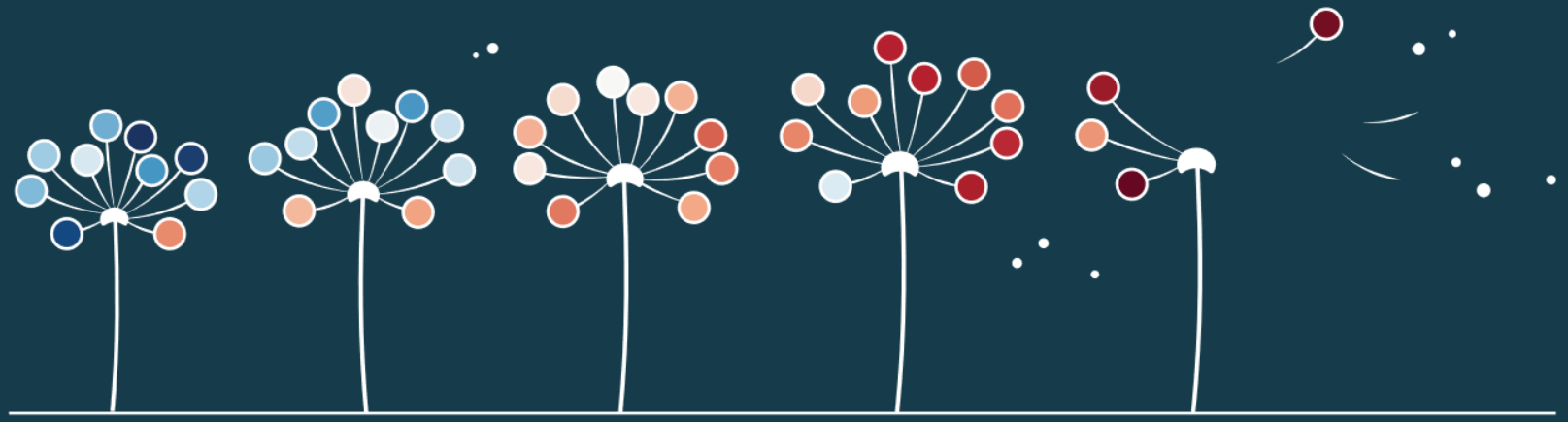


Forecasting in a changing climate……

https://climate.copernicus.eu/esotc/2023

EUROPEAN STATE OF THE CLIMATE

SUMMARY 2023



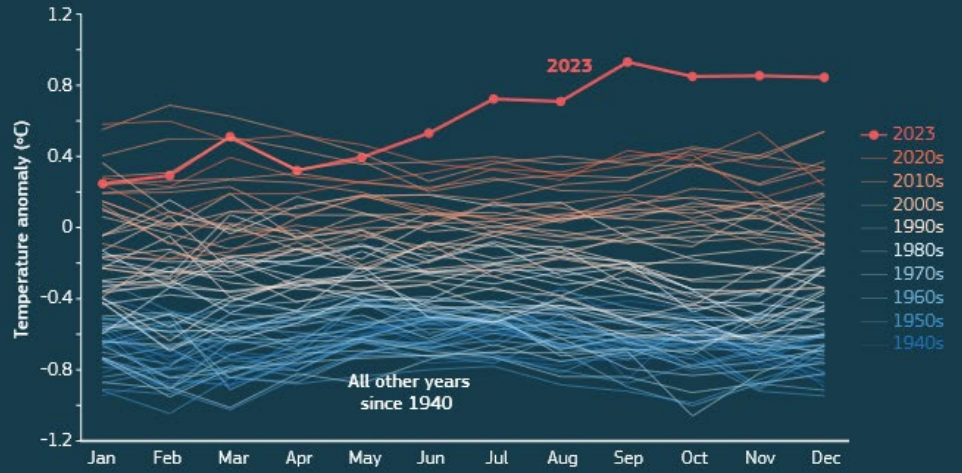
Globe in 2023

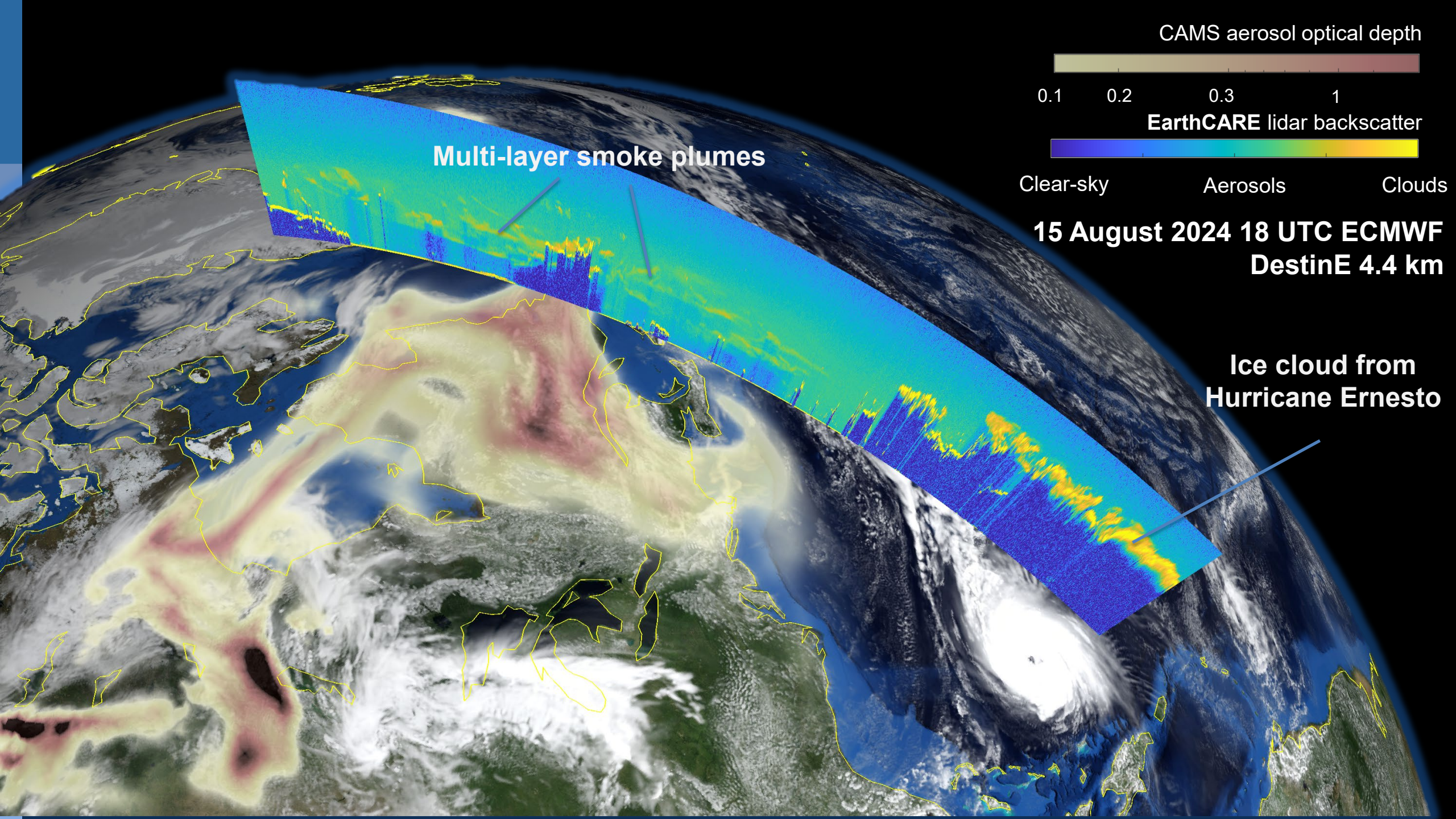
The ***global context*** is provided by C3S Climate Indicators.

Additional information about the global climate during 2023 can be found in the ***WMO State of the Global Climate in 2023***, and the ***C3S 2023 Global Climate Highlights***.

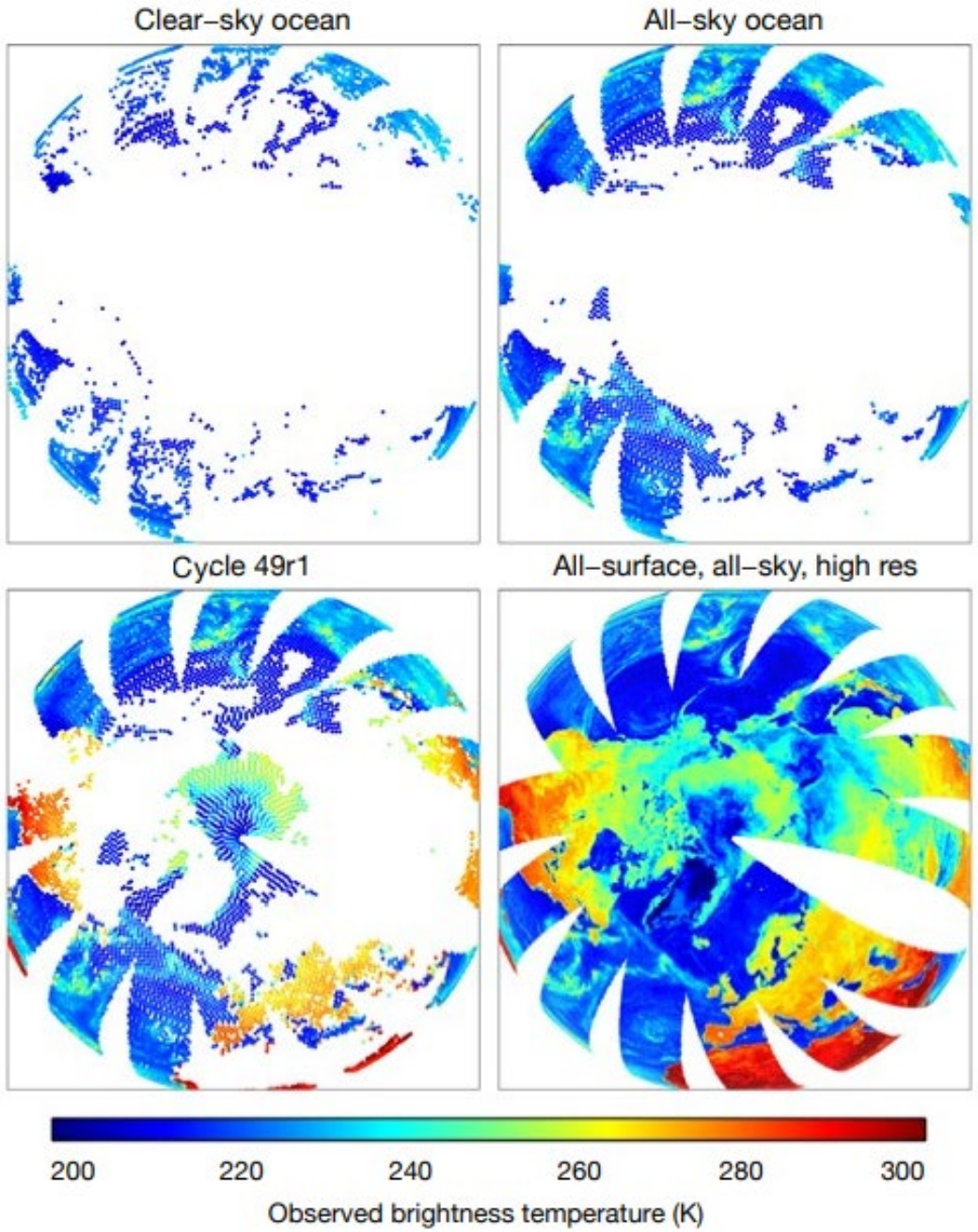
Global surface air temperature anomalies

Data: ERA5 1940–2023 • Reference period: 1991–2020 • Credit: C3S/ECMWF



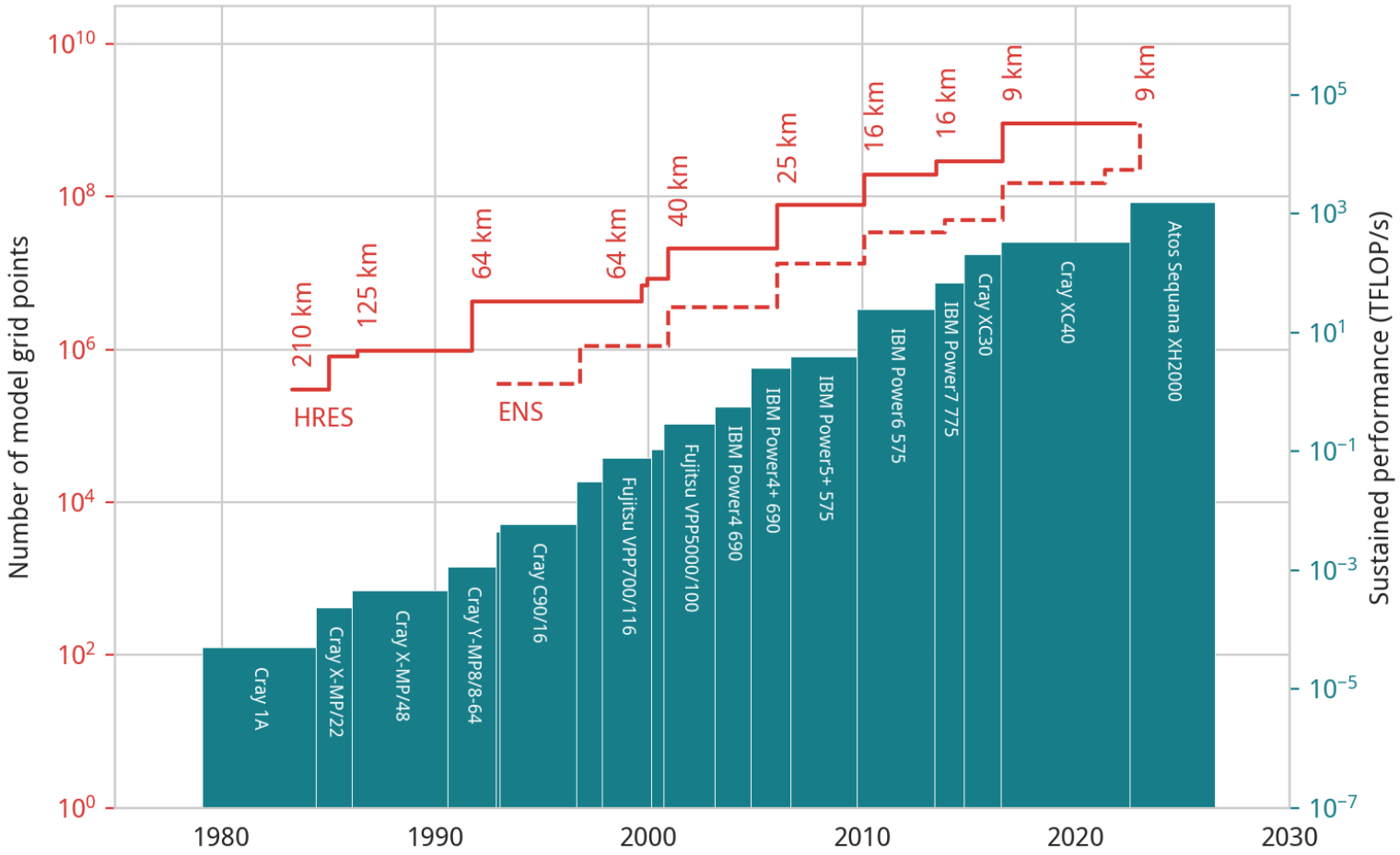

CAMS aerosol optical depth
0.1
0.2
0.3
1
EarthCARE lidar backscatter
Clear-sky
Aerosols
Clouds
Multi-layer smoke plumes
15 August 2024 18 UTC ECMWF
DestinE 4.4 km
Ice cloud from
Hurricane Ernesto

Innovating in the exploitation
of satellite data:
towards all-sky, all-surface



AMSR2 observed
brightness temperatures
37 GHz v-polarised channel

New challenges and opportunities in computational science



- Exploiting new architectures (e.g. GPU)
- New workflows
- Dealing with increasing data volumes
- Cloud
- ……

Digital Twins of the earth system

Bespoke simulation capability to assess the impact of “what-if” scenarios and questions on climate and extreme events, and provide globally consistent information at km-scale scales where these impacts are observed

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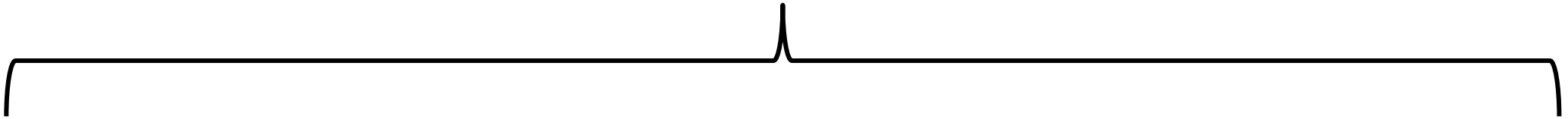
Top HPC-Enabled Scientific Achievement

HPCwire 2024 READERS' CHOICE AWARDS
Best Use of HPC in Physical Sciences

Machine Learning at ECMWF



The hybrid model

Enhanced and accelerated implementation of ECMWF ML Roadmap

Delivering results

Development of a ML ensemble forecast

Data-driven model initialised with NWP analysis hence requiring conventional data assimilation.

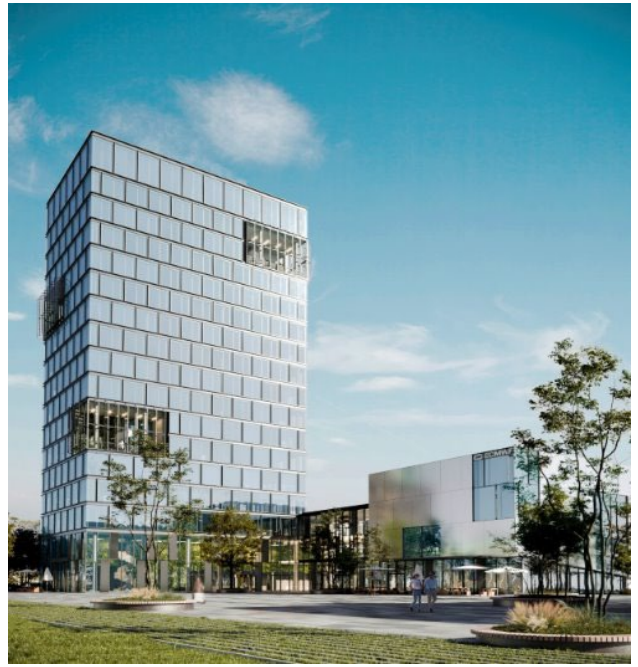
Embracing novelty

Observations-driven ML system

A whole system reinventing the path from observations to predictions.

A scientific challenge

ECMWF collaborative project with Member States is one project of wider EUMETNET programme



FOR MED

THE STRENGTH OF A COMMON GOAL

ECMWF STRATEGY 2025–2034

Our Vision:

World-leading monitoring and predictions of the Earth system enabled by cutting-edge physical, computational and data science, resulting from a close collaboration between ECMWF and the members of the European Meteorological Infrastructure, will contribute to a safe and thriving society

ECMWF in 2035:

- Innovating at the cutting edge of physical, computational and data science for environmental monitoring and prediction
- Delivering forecast tools and products of unprecedented quality, exploiting data-driven methods anchored on physics-based modelling
- Integrated in and collaborating with the wider European meteorological community to deliver maximum value to society

Our Mission: Deliver global numerical weather predictions focusing on the medium-range and monitoring of the Earth system to and with our Member States

Strategic Pillars and Actions:

Science & Technology

- Improve use of observations & Earth system data assimilation
- Improve seamless Earth system models
- Exploit high-performance computing, technology & computational science for numerical weather prediction
- Harness artificial intelligence/machine learning for data-driven forecasting
- Optimise system design & enhance flow from research to operations & vice versa

Impact

- Meet users' needs & deliver world-leading quality products
- Optimise provision & sharing of data, tools & resources
- Enhance partnerships, training & communications

Organisation & People

- Increase organisational performance, resilience & effectiveness
- Enable a thriving multi-site environment with an emphasis on sustainability

https://www.ecmwf.int/en/about/what-we-do/strategy

ECMWF in 2035……

Innovating at the cutting edge of physical, computational and data science for environmental monitoring and prediction.

Delivering forecast tools and products of unprecedented quality, exploiting data-driven methods anchored on physics-based modelling.

Integrated in and collaborating with the wider European meteorological community to deliver maximum value to society.